



Sensors and Automation

Cavity-Enhanced Gas Analyzer for Process Control Applications

Ethylene is the largest volume, largest revenue-generating organic chemical produced. Its production uses more energy than any other chemical. Ethylene finds widespread use, serving as the building block for 50% of all organic chemicals and polymers. However, manufacturers who produce polymer-grade ethylene must constantly monitor, and if necessary hydrogenate, any acetylene that may be present in ethylene flows. Such measures are imperative because too high an increase in acetylene concentration has the potential to contaminate both the catalytic bed and the stored finished product. In fact, if left unchecked for too long, acetylene contamination can cost a chemical manufacturer more than \$200,000 in losses per event. As a result, the ability to quickly and accurately monitor trace levels of acetylene levels is a critical need for ethylene manufacturers.

Traditionally, gas chromatography (GC) has been the chosen technology for measuring acetylene contamination in ethylene flows. While this technology is sensitive enough to measure acetylene in amounts less than 1 ppm, it is

relatively time-consuming in that it takes at least two minutes for each measurement. This time lapse can lead to higher costs due to delayed contaminate detection. GC equipment costs are also relatively high, adding up to approximately \$1 million for a 15-year period, per GC unit.



Los Gatos Research is developing an industrial process control monitor that can replace gas chromatography. The new monitor will employ a patented technology – developed by Los Gatos Research – called Off-Axis Integrated Cavity Output Spectroscopy (ICOS) – that utilizes a variation of absorption spectroscopy. A robust technology, Off-Axis ICOS retains the sensitivity of older detection methods, while providing an absolute, accurate measurement of acetylene contamination that is fifty times faster and one-third less expensive.

Applications and Benefits

An industrial process control analyzer will help ethylene producers avoid losses related to acetylene upsets. Other benefits stemming from this project include:

- Utilization of technology in other sectors, including environmental monitoring and vehicle emissions testing.
- Increased process efficiency during chemical manufacturing.
- The ability to more strictly monitor emissions that will result in their reduction.

Project Participants

- Los Gatos Research (Lead organization)
- Dow Chemical Company
- Analytical Specialties, Inc.
- U.S. Department of Energy, Small Business Innovative Research Program

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Project Plans and Progress

Project History: This project was awarded under the SBIR solicitation. SBIR projects are conducted in multiple phases: Phase I awards were made in the spring of 2002, while Phase II awards were made in the spring of 2003.

Past Accomplishments

In Phase I, researchers sought to determine the technical feasibility of applying Off-Axis ICOS technology to detect acetylene contamination in ethylene gas flows. Objectives for this now-completed phase included:

- Automation of sample handling, measurement, and analysis to permit remote, long-term operation.
- Performance of long-term testing of the system to evaluate its feasibility in process control and its operational costs.
- Analysis of actual process gas samples to demonstrate the instrument's utility, sensitivity, and accuracy.

Future Plans

To meet Phase II objectives, researchers will:

- Build and test an Off-Axis ICOS industrial process control instrument suitable for direct insertion into Dow Chemical Company's ethylene production facility.
- Perform lab and field tests of the IPC prototype at Dow Chemical Company and make any necessary modifications.
- Adapt the IPC system to measure multiple contaminants in ethylene.



Sensors and Automation

The Sensors and Automation Activity (S&A), part of the Industrial Technologies Program, develops and deploys integrated measurement systems for operator-independent control of manufacturing processes with broad applicability across multiple industry sectors.

The industry sectors served by S&A are those that have established partnerships with the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy to collaborate in joint technology development for the competitiveness and vitality of the industry.

Work done under S&A will lead in providing the advanced measurement and control technology solutions to meet the needs of all industry sectors supported by the IOF strategy.

To learn more about S&A activities, visit the program web site at:

www.oit.doe.gov/sens_cont/

A Strong Energy Portfolio for a Strong America

Energy Efficiency and clean, renewable energy will mean a stronger economy, a cleaner environment, and greater energy independence for America. Working with a wide array of state, community, industry, and university partners, the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy invests in a diverse portfolio of energy technologies.

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